



# International Nuclear Safety Center

## Monthly Report

(Period Ending 28 February 1999)

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This report is available on the Internet <http://www.insc.anl.gov>

### Current Items:

Contract Developments - Initially, all of the work at RINSC that was supported by DOE was done through Work Orders written under a Basic Ordering Agreement (BOA) between ANL and the Research and Development Institute for Power Engineering (RDIPE/NIKIET) because at that time RINSC was not an autonomous organization under MINATOM. In April 1998 RINSC became an autonomous organization under MINATOM and in August 1998 a new Basic Ordering Agreement was signed by ANL and RINSC. Because the State Department has instituted sanctions against NIKIET, the Work Orders under the BOA with NIKIET have been closed. Most of the work that was to be done under those Work Orders has been completed; the work which was still outstanding has been deobligated and will be put into new Work Orders written under the BOA with RINSC.

Joint RINSC/USINSC Paper on Code Validation - A paper on the methodology used in the development of the RELAP5 validation plans for VVER and RBMK reactors will be presented at the second International Symposium on the Validation of Systems Transients Analysis Codes during the ASME/JSME Joint Fluids Engineering Conference in San Francisco in July 1999. The final version of the paper has been submitted and accepted.

Joint RINSC/USINSC Paper on Code Assessment - A paper based on the assessment of the VNIIEF's KORAT-3D parallel code performance on the ANL IBM SP computer was jointly written by RINSC and USINSC participants and forwarded to the ANS for review and publication. The title of the paper is "Performance Assessment of KORAT-3D on ANL IBM-SP Computer." The work contained in the paper was done during the INSC technical staff exchange program in September 1998. The paper has been reviewed by the ANS and has been accepted for publication in the ANS Transactions of the upcoming June 1999 National Meeting, to be held in Boston.

OECD/NEA Main Steamline Break Benchmark Problem - USINSC participants have completed the analysis of Phase 2 problems of the OECD/Nuclear Energy Agency PWR Main Steamline Break (MSLB) benchmark exercise. The results generated with the SAS-DIF3DK code have been collated and forwarded to the benchmark organizers for intercomparison with other code results. The benchmark problem, which is designed for verification and testing of coupled neutronic and thermal-hydraulic codes, was selected as an international benchmark problem that could be used for verifying RINSC codes designed for analyzing pressurized water-cooled reactors (VVERs and PWRs). It is anticipated that in the near future the Russian solutions will be generated and compared to SAS-DIF3DK and other Western code solutions.



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### Current Items: (cont'd)

Structural Analysis Joint Project - The RINSC and USINSC are participating in the International Round Robin Analysis of Containment Structures. The second phase of the round robin is in progress and is focused on the simulation of a prestressed concrete containment vessel (PCCV) that is subjected to internal pressurization. The PCCV model is a 1:4 scale model of a pressurized water reactor (PWR) containment. The physical model includes a steel liner with various penetrations (i.e., equipment hatch, airlock, main steam and feed water lines).

The RINSC analysts have completed the development of a three-dimensional model of the PCCV that will be used with the DANCO code and their calculations will begin shortly. The USINSC analysts have completed preliminary pretest predictions for the response of the PCCV using a two-dimensional axisymmetric model and the TEMP-STRESS code. The numerical model consists of the reinforced concrete, meridional prestress tendons, hoop prestress tendons and the liner. Since the numerical model is axisymmetric, only the response of the PCCV in the free field can be determined.

A separate three-dimensional, finite element model is being developed by the USINSC to capture the effects around the penetrations. This model will also better represent the orientations of the prestressing tendons that are located in the hoop and meridional directions. In addition to the model development, the three-dimensional NEPTUNE code is being enhanced with the capability to perform tendon prestressing. Calculations will begin after the pretension scheme is verified and validated.

Upgrades to the INSC Material Properties Database - Data assessments and recommendations for the thermal expansion of Zircaloy and the surface tension of zirconium have been added to the database. The recommendations for Zircaloy thermal expansion in the  $\alpha$ -phase include the single-crystal equations and transformation equations given in the MATPRO and axial and diametral equations for Zircaloy cladding. New equations were determined for Zircaloy thermal expansion in the  $\alpha$ -phase and the transition region between the MATPRO single-crystal equations for these regions are not consistent with the available data for Zircaloy cladding in the axial direction. The recommended equation for the axial thermal expansion in the  $\alpha$ -phase has the same slope as the MATPRO  $\alpha$ -phase single crystal equations, which is identical with the slope for the average thermal expansion of zirconium in the  $\alpha$ -phase.

The recommended value,  $1455 + 55 \text{ mN} \cdot ^{-1}$ , for the surface tension of zirconium at the melting point is based on the four most recent measurements that have used high-vacuum techniques to obtain very pure samples. The lack of any data as a function of temperature makes it impossible to make a recommendation as a function of temperature.



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### **Current Items: (cont'd)**

Assessment of the zirconium surface tension data showed that the largest contributor to the surface tension uncertainty is from the estimated liquid density because no measurements are available. Reliable liquid zirconium densities are also required for determination of dynamic viscosities from kinematic viscosity measurements and for modeling the behavior of liquid mixtures that include zirconium that are relevant to severe accidents. A. I. Savvatimsky of IVTAN has proposed evaluation of various density measurement techniques for liquid metals and the measurement of the density of liquid zirconium as a function of temperature from the melting point to ~4000 K as part of Phase III of the joint USINSC/RINSC project on material properties.

### **Activities Calendar:**

**All travel to Russia and all meetings with the RINSC staff and the scientists associated with the RINSC Joint Projects have been postponed until there is resolution of the impact of the State Department sanctions on NIKIET on the work being done with RINSC.**